

Envelopes of Signals via Medmax

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Description

Our goal is to find the envelope of a signal. We suggest the Medmax algorithm for this purpose. The algorithm is an elaboration of the median filter, however it allows different order statistics.

Mathematical Principles

There are various algorithms for finding envelopes of signals. The most well-known is by applying the Hilbert transform $H(f)$ of the signal f and assigning $\|(f, H(f))\|_2$ as the envelope. However, this method will work well only for uniform frequencies bounded by the envelope and will work badly when having combinations of many frequencies.

For the purpose of general signals we suggest using a nonlinear filter. Two filters come to mind: median filter and max filter. The median filter computes the local median, whereas the max filter computes the local max. The former one can be a lower bound for a true envelope, while the latter one an upper bound. To get a more coherent notion of an envelope we allow playing with different local order statistics, having both max and median filters as special cases (e.g. when order statistics is 1 we get the max filter and when the order statistics is $\frac{m}{2}$ we get the median statistics. In practice, we suggest choosing a value closer to 1 (but different than 1) and thus relaxing a bit the max filter.

Relation to Metrics Criteria

The envelope is a significant property of the signal and two signal can be compared based on their envelope (by a functional distance).

Usage

The algorithm is very easy to use and its code is supplemented. There are two parameters, local window width and the order statistics. Based on our experience we suggest the window size n to be 10 and the order o to be the third large value.